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The Natural History of Appendicitis in Adults

A Prospective Study

Claire L. Temple, B.A., Shirley A. Huchcroft, Ph.D., and Walley J. Temple, M.D.

From the Department of Surgery, Foothills Hospital/University of Calgary, Calgary, Alberta, Canada

Objective
The authors relate prehospital delay and in-hospital delay to the incidence of perforation of appendicitis.

Summary Background Data
Quality assurance studies use perforation rate as an index of quality of care. This is based on the assumption commonly presented in retrospective reports that in-hospital delay to surgery influences the incidence of perforation. Only one limited study prospectively found that prehospital delay increased the perforation rate.

Methods
During a 6-month period, 95 consecutive adults undergoing appendectomies at Foothills Hospital in Calgary, Alberta, were questioned as to onset and type of first symptom (i.e., epigastric discomfort, anorexia nervosa, vomiting, and abdominal pain). Time of emergency room (ER) arrival, surgery consultation, and operating room start were taken from the chart. Surgical and pathology reports were used to identify status of appendix (normal, inflamed, suppurative, gangrenous, perforated) and presence of abscess cavity. The status of appendix was related to prehospital and in-hospital delay to establish significance.

Results
There were 13 (14%) normal, 67 (70%) inflamed, and 15 (16%) perforated appendices. Patients with perforated appendices waited 2.5 times longer before reporting to the ER, compared with patients with inflamed appendices (57 hours *vs.* 22 hours, $p < 0.007$). Once in the hospital, patients with perforated appendices were identified and treated faster than those with inflamed appendices (7 *vs.* 9 hours, $p < 0.039$). Analysis by ER physician was 3 hours whether the appendix was normal, inflamed, or perforated. Analysis by the surgeon was significantly shorter in patients with perforated appendices than patients with inflamed appendices (4 *vs.* 6 hours, $p < 0.039$).

Conclusions
This prospective study identifies that delay in presentation accounts for the majority of perforated

appendices. Clinical evaluation is effective for identifying patients with more advanced disease. Indiscriminate appendectomy as an attempt to decrease perforation is not supported by these data. Hospital perforation rates likely reflect patient factors, illness attitude, and access to medical care.

The presumption that perforated appendicitis is a time-related phenomenon is a rational analysis of basic microbiologic concepts. Based on this, in-hospital evaluation and observation time have been implicated as the critical portion of the adverse event, neglecting the potential importance of patient delay in reporting to the hospital.

Many authors advocate the sacrifice of diagnostic accuracy and hence, more normal appendectomies as an attempt to decrease the rate of perforated appendices. This has fostered quality assurance programs based on perforation rate as a physician-dependent event. This is based on regression analysis of 18 retrospective studies that inversely correlate normal with perforated appendices.[1] To date, no one has established a causal relationship between the two. This potentially erroneous conclusion has the distinct possibility of increasing morbidity of unnecessary surgery and hospital costs. Our clinical impression in the urban community is that the perforation of the diseased appendix is largely determined by the prehospital phase of the patients's illness. To resolve this controversy, we embarked on a prospective study of patients with appendectomies to correlate the timing of prehospital and in-hospital portions of the illness with the incidence of perforated appendices.

METHODS

In 1991, 95 consecutive patients undergoing appendectomy at the Foothills Hospital were monitored prospectively as part of ongoing quality assurance. The surgeon, having evaluated a patient, booked the patient based on the urgency of the illness, either within the hour or within 6 hours, bumping all less urgent cases. A study assistant recorded four times:

1. Onset of first symptom;
2. Presentation to the ER;
3. Surgery consult;
4. Appendectomy.

From these times it was possible to calculate the following:

1. Prehospital symptoms (2 minus 1);
2. In-hospital evaluation (4 minus 2);
3. Evaluation by the ER physician (3 minus 2);
4. Evaluation by the surgeon (4 minus 3);
5. Total time (4 minus 1).

The incidence of normal appendices, inflamed appendices, and perforated appendices was determined by the surgeon and by the pathologist. Perforation was defined as having a visible hole in the appendix. Appendices that had necrotic areas or were surrounded by pus, but had no perforation grossly or microscopically, were classified as nonperforated.

The variability of prehospital length of symptoms, in-hospital evaluation, and total time from first symptom to surgery each were correlated with perforation rate using analysis of variance to determine significant relationships.

RESULTS

A total of 95 consecutive adult (>15 years old) patients with appendectomies were evaluated. Of these appendices, 13.6% (13 of 95) were normal, 70.5% (67 of 95) were acutely inflamed, and 15.7% (15 of 95) were perforated. The following data were found (Table 1).

The average time of prehospital symptoms was longer for patients with perforated appendices (57.13 hours) than those with inflamed appendices (22.22 hours). The average delay for surgery to start once the patient had arrived at the ER was shorter for patients with perforated appendices (6.53 hours) than for those with inflamed appendices (8.79 hours) ($p < 0.022$ TREND).

In-hospital delay could be further broken down into

Table 1. EVOLUTION OF APPENDICITIS

	Prehospital Symptoms (hrs)	In-Hospital Evaluation (hrs)	Total Time (hrs)
Inflamed	22.22* (±18.66)	8.79† (±6.31)	31.00 (±18.78)
Perforated	57.31* (±41.55)	6.53† (±3.27)	63.85 (±41.48)

* $p < 0.0043$ ANOVA.
† $p < 0.039$ trend (includes normal appendices of 187 ± 398 hrs).

Address for correspondence and reprints: Dr. W. J. Temple, Tom Baker Cancer Centre 1331—29 Street NW, Calgary, AB, Canada, T2N 4N2.

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Table 2. IN-HOSPITAL TRIAGE OF APPENDICITIS

	Evaluation by ER Physician (Hrs Between ER Arrival and Surgery Consult)	Evaluation by Surgeon (Hrs Between Surgical Consultation and Operation Start)	Total Length of In-Hospital Evaluation (hrs)
Inflamed	3.72 (±2.90)	5.47* (±5.69)	8.79† (±6.31)
Perforated	2.81 (±2.61)	3.72* (±2.61)	6.53† (±3.27)

* $p < 0.022$.
† $p < 0.035$ trend (includes normal appendices 9.3 ± 11 hrs).

evaluation by ER physician and evaluation by surgeon (Table 2).

Patients with inflamed and perforated appendices were evaluated for approximately 3 hours by the emergency physician. Delay by the surgeon was much less for patients with perforated appendices (3.72 hours) than for those with inflamed appendices (5.47 hours; $p < 0.022$).

Although total time from the first symptom for perforated appendices averaged 63.85 hours, some perforated appendices ruptured very quickly. Three of the 15 perforated appendices (20%) ruptured within 27 hours of the onset of first symptom (11.3 hours, 20.3 hours, 23.7 hours)

In the series of 95 patients, 1 patient with a perforation had a complication of pelvic abscess. This patient had a 70-hour delay before admission to the ER, and ultimately died in the hospital 40 days later from other causes (85-year-old man, died with MI and CVA). Length of stay for patients with inflamed appendices averaged 4 days (±3); patients with perforated appendices stayed an average of 7 days (±3) in the hospital (excluding aforementioned patient who stayed in hospital 40 days with complications of myocardial infarction and cerebrovascular accident).

DISCUSSION

This unique study documents that patient factors are the most critical component influencing perforation of the appendix. This is supported by other data. White et al. concluded in a prospective study that few ruptures occur while patients are in the hospital, and that it is possible to sort out perforated appendices when they arrive there.[2] Following this scheme, they reduced negative laparotomy rate from 15% to 2%, with no change in perforation rate or mortality. Thomson et al.[3] corroborated that active in-hospital observation in acute abdominal pain can significantly decrease the normal appendectomy rate. Moss et al. prospectively identify increasing prehospital phase in a large cohort of patients with appendicitis to be associated with advanced pathology but do not examine, in isolation, the influence on perforation alone.[4]

Retrospective studies have demonstrated a direct relationship between symptom duration and perforation rate. However, these studies fail to break up the symptom duration into prehospital and in-hospital time frames. In one such retrospective study, Tamir et al. found that in pregnant women, symptoms exceeding 24 hours were the critical factor determining perforation.[4] This author urged prompt exploration of suspect appendicitis, yet the paper failed to quantify whether the delay in surgery was attributable to patient tardiness in reporting to the ER or to in-hospital delay in diagnosis. Similarly, a retrospective study of childhood appendicitis found that children with symptoms for 48 hours or more had a perforation rate of 98%.[5] Once again, the paper neglected to describe which portion of this 48 hours was spent out of hospital and which portion was spent in hospital.

Our study agrees that perforation rate increases with length of symptoms—in this series, patients with perforated appendices have symptoms 2.57 times longer than patients with inflamed appendices. When the symptom duration is broken down into out-of-hospital and in-hospital times, the waiting occurs in the prehospital phase of the patient's illness. The delay to surgery is not the result of inordinate in-hospital delays; rather, patients with perforated appendices received surgery sooner than patients with inflamed appendices, likely because of the ability of the physician to recognize the clinical severity of their symptoms.

In-hospital delay can be divided further into two components. First, the patient is evaluated by an ER physician who requests a surgery consultation. In both the inflamed and perforated groups, 3 hours were spent in the ER evaluating the patient. Second, the surgeon analyzes the situation and books the surgery in a time period that reflects the urgency of the case. Patients with perforated appendices had been rushed to the operating room within 3.72 hours after this consultation; patients with inflamed appendices had waited an average of 5.47 hours for their surgery. This indicates that patients with perforated appendices have more distress and that the surgeon hastens them into the operating room. Thus, the patient appears to have perforated before reporting to hospital, not while waiting for the operating room.

Although the length of symptoms correlates with perforation, three patients (20% of the perforated appendi-

ces) in our study perforated within 24 hours between onset of first symptom and surgery. The natural history may be influenced in a small proportion of patients by factors other than a timely progression. Age, bacteriology, and mechanism of obstruction were not studied, but may be important factors in the natural history of the appendix.

This study refutes the observation that imprecision of the diagnosis of appendicitis by indiscriminate appendectomy is justified to significantly decrease perforation rate. This study also underlines how unsupported conclusions based on inappropriate data may lead to a lack of quality assurance. We conclude that in the urban setting in a university and community hospital, the triage of patients to urgent surgery or observation for possible appendicitis may be safely done.

References

1. Velanovich V, Satava R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implication for quality assurance. Am Surg 1992; 58:264–269.
2. White JJ, Santillana M, Haller JA. Intensive in-hospital observation: a safe way to decrease unnecessary appendectomy. Am Surg 1975; 41:793–798.
3. Thomson HJ, Jones PF. Active observation in acute abdominal pain. Am J Surg 1986; 152:522–525.
4. Moss JG, Barrie JL, Gunn AA. Delay in surgery for acute appendicitis. J R Coll Surg Edinb 1985; 30:290–293.
5. Tamir LL, Bongard FS, Klein SR. Acute appendicitis in the pregnant patient. Am J Surg 1990; 160:571–576.
6. Rappaport WD, Peterson M, Stanton C. Factors responsible for the high perforation rate seen in early childhood appendicitis. Am Surg 1989; 55:602–605.